

**Coho and Chinook Salmon Smolt Releases into Cook
Inlet, Prince William Sound, and Resurrection Bay,
Alaska, 2010**

by

Diane P. Loopstra

and

Patricia A. Hansen

September 2015

Alaska Department of Fish and Game

Divisions of Sport Fish and Commercial Fisheries



Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)		General		Mathematics, statistics	
centimeter	cm	Alaska Administrative Code		all standard mathematical signs, symbols and abbreviations	
deciliter	dL		AAC		
gram	g	all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.	alternate hypothesis	H _A
hectare	ha			base of natural logarithm	<i>e</i>
kilogram	kg	all commonly accepted		catch per unit effort	CPUE
kilometer	km	professional titles	e.g., Dr., Ph.D., R.N., etc.	coefficient of variation	CV
liter	L			common test statistics	(F, t, χ^2 , etc.)
meter	m	at	@	confidence interval	CI
milliliter	mL	compass directions:		correlation coefficient (multiple)	R
millimeter	mm	east	E	correlation coefficient (simple)	r
Weights and measures (English)		north	N	covariance	cov
cubic feet per second	ft ³ /s	south	S	degree (angular)	°
foot	ft	west	W	degrees of freedom	df
gallon	gal	copyright	©	expected value	<i>E</i>
inch	in	corporate suffixes:		greater than	>
mile	mi	Company	Co.	greater than or equal to	≥
nautical mile	nmi	Corporation	Corp.	harvest per unit effort	HPUE
ounce	oz	Incorporated	Inc.	less than	<
pound	lb	Limited	Ltd.	less than or equal to	≤
quart	qt	District of Columbia	D.C.	logarithm (natural)	ln
yard	yd	et alii (and others)	et al.	logarithm (base 10)	log
		et cetera (and so forth)	etc.	logarithm (specify base)	log ₂ , etc.
Time and temperature		exempli gratia		minute (angular)	'
day	d	(for example)	e.g.	not significant	NS
degrees Celsius	°C	Federal Information Code	FIC	null hypothesis	H ₀
degrees Fahrenheit	°F	id est (that is)	i.e.	percent	%
degrees kelvin	K	latitude or longitude	lat or long	probability	P
hour	h	monetary symbols		probability of a type I error	
minute	min	(U.S.)	\$, ¢	(rejection of the null hypothesis when true)	α
second	s	months (tables and figures): first three		probability of a type II error	
Physics and chemistry		letters	Jan,...,Dec	(acceptance of the null hypothesis when false)	β
all atomic symbols		registered trademark	®	second (angular)	"
alternating current	AC	trademark	™	standard deviation	SD
ampere	A	United States		standard error	SE
calorie	cal	(adjective)	U.S.	variance	
direct current	DC	United States of America (noun)	USA	population sample	Var var
hertz	Hz	U.S.C.	United States Code		
horsepower	hp				
hydrogen ion activity (negative log of)	pH	U.S. state	use two-letter abbreviations (e.g., AK, WA)		
parts per million	ppm				
parts per thousand	ppt, ‰				
volts	V				
watts	W				

FISHERY DATA SERIES NO. 15-30

**COHO AND CHINOOK SALMON SMOLT RELEASES INTO COOK
INLET, PRINCE WILLIAM SOUND, AND RESURRECTION BAY,
ALASKA, 2010**

by
Diane P. Loopstra
Alaska Department of Fish and Game, Division of Sport Fish, Anchorage
and
Patricia A. Hansen
Alaska Department of Fish and Game, Research and Technical Services, Anchorage

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1565

September 2015

This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777K) under Project F-10-25, Job No. S-2-12.

ADF&G Fishery Data Series was established in 1987 for the publication of Division of Sport Fish technically oriented results for a single project or group of closely related projects, and in 2004 became a joint divisional series with the Division of Commercial Fisheries. Fishery Data Series reports are intended for fishery and other technical professionals and are available through the Alaska State Library and on the Internet: <http://www.adfg.alaska.gov/sf/publications/>. This publication has undergone editorial and peer review.

*Diane P. Loopstra,
Alaska Department of Fish and Game, Division of Sport Fish,
333 Raspberry Road, Anchorage, Alaska 99518-1599, USA*

and

*Patricia A. Hansen,
Alaska Department of Fish and Game, Research and Technical Services,
333 Raspberry Road, Anchorage, Alaska 99518-1599, USA*

This document should be cited as:

Loopstra, D. P., and P. A. Hansen. 2015. Coho and Chinook salmon smolt releases into Cook Inlet, Prince William Sound, and Resurrection Bay, Alaska, 2010. Alaska Department of Fish and Game, Fishery Data Series No. 15-30, Anchorage.

The Alaska Department of Fish and Game (ADF&G) administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act (ADA) of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility please write:

ADF&G ADA Coordinator, P.O. Box 115526, Juneau, AK 99811-5526

U.S. Fish and Wildlife Service, 4401 N. Fairfax Drive, MS 2042, Arlington, VA 22203

Office of Equal Opportunity, U.S. Department of the Interior, 1849 C Street NW MS 5230, Washington DC 20240

The department's ADA Coordinator can be reached via phone at the following numbers:

(VOICE) 907-465-6077, (Statewide Telecommunication Device for the Deaf) 1-800-478-3648,

(Juneau TDD) 907-465-3646, or (FAX) 907-465-6078

For information on alternative formats and questions on this publication, please contact:

ADF&G, Division of Sport Fish, Research and Technical Services, 333 Raspberry Rd, Anchorage AK 99518 (907) 267-2375

TABLE OF CONTENTS

	Page
LIST OF TABLES.....	ii
LIST OF FIGURES	ii
LIST OF APPENDICES	ii
ABSTRACT	1
INTRODUCTION.....	1
METHODS.....	2
Smolt Marking.....	3
Coded Wire Tagging.....	3
Thermal Marks (TMs)	6
Smolt Enumeration	9
Tagging Inventory (TI)	9
Hatchery Inventory (HI) Estimates	9
Volumetric Estimates (WV)	10
Size Estimation	11
RESULTS.....	11
Smolt Marking.....	11
Coded Wire Tagging (CWTs).....	11
Thermal Marks (TMs)	11
Smolt Releases.....	11
Smolt Enumeration	11
Size Estimation	13
DISCUSSION.....	13
Smolt Marking.....	13
Thermal Marking	13
Smolt Enumeration	14
Size Estimation	14
RECOMMENDATIONS.....	15
ACKNOWLEDGMENTS	15
REFERENCES CITED	16
APPENDIX A: HISTORICAL RELEASES OF CHINOOK AND COHO SALMON SMOLT	17
APPENDIX B: DISPLACEMENT VALUES FOR FISH TRANSPORT TANKS	33

LIST OF TABLES

Table	Page
1 Total number of fish stocked at 15 locations in Cook Inlet, Prince William Sound, and Resurrection Bay in 2010.	2
2 Summary of coded-wire-tagging data and smolt release estimates for Chinook salmon stocked in Cook Inlet, 2010.	4
3 Summary of Chinook and coho salmon thermal marks for smolt stocked at locations in Cook Inlet, Prince William Sound, and Resurrection Bay in 2010.	7
4 A comparison of hatchery inventory estimates, water volume displacement population estimates, and tagging inventory counts for Chinook and coho salmon reared at Fort Richardson and Elmendorf hatcheries and released in 2010.	12
5 The percentage of fish within, below, or above production goal target size for CWT-tagged Chinook salmon release groups and 1 coho salmon release group from Fort Richardson Hatchery in 2010.	13

LIST OF FIGURES

Figure	Page
1 Proper placement of a coded wire tag in a small fish.	5
2 Image of a thermal mark applied to Chinook salmon released into Cook Inlet.....	8
3 Thermal marking temperature profile for Chinook salmon released into Cook Inlet in 2010 with a thermal mark of 2,3H.	9

LIST OF APPENDICES

Appendix	Page
A1 Historical releases of coho salmon smolt with numbers of thermally marked, adipose finclipped, and coded-wire-tagged fish.	18
A2 Historical releases of Chinook salmon smolt with numbers of thermally marked, adipose finclipped, and coded-wire-tagged fish.	23
B1 Displacement values for fish transport tanks.....	34

ABSTRACT

In 2010, the Alaska Department of Fish and Game released approximately 989,351 coho salmon (*Oncorhynchus kisutch*) smolt and 1,797,751 Chinook salmon (*O. tshawytscha*) smolt in Cook Inlet, Prince William Sound, and Resurrection Bay to increase angling opportunity and relieve angling pressure on wild stock salmon populations. There were 13 Chinook salmon and 7 coho salmon release groups in all. Every smolt in each release group was thermally marked to later identify the release area of returning adults. Chinook salmon smolt from 3 groups released at brood collection sites (319,567 thermally marked fish) were also marked with an adipose fin clip and a coded wire tag to identify hatchery fish (adipose fin missing) from naturally produced fish (adipose fin present) in the fishery, brood collections, and escapements at those sites. For individual release groups, the percentage of fish retaining coded wire tags ranged from 98.2% to 99.8%. Fish size distribution at time of release was estimated for all 3 coded-wire-tagged Chinook salmon release groups and 1 coho salmon release group without coded wire tags. All 3 of the coded-wire-tagged Chinook salmon release groups achieved a smolt production goal of 80% within a target size range of 5.1–15.0 g. Although the coho salmon smolt production goal was to have 80% of the release group within a target size range of 15.1–25.0 g, only 50.8% fell within the target size range. Smolt were enumerated in the 3 coded-wire-tagged Chinook salmon release groups. Hatchery inventory methods were used to estimate the number of all 7 coho salmon release groups and the 10 Chinook salmon release groups that did not receive adipose fin clips and coded wire tags.

Key words: hatchery, adipose finclip, coded wire tags, thermal marking, otolith, Chinook salmon, *Oncorhynchus tshawytscha*, coho salmon, *Oncorhynchus kisutch*, tag retention, size composition.

INTRODUCTION

Southcentral Alaska receives most of the state's sport fishing effort. Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) smolt reared at Alaska Department of Fish and Game (ADF&G) Division of Sport Fish (SF) hatcheries have been stocked in numerous locations throughout Southcentral Alaska to improve or create terminal sport fisheries and relieve pressure on wild stocks (Appendices A1 and A2). One element of the coho and Chinook salmon hatchery smolt stocking projects in Cook Inlet, Prince William Sound, and Resurrection Bay is the use of thermal marks (TM) to identify fish. All fish raised at both Fort Richardson Hatchery (FRH) and Elmendorf Hatchery (EH) are thermal marked. In 2010, 100% of 3 release groups of salmon smolt were also marked with an adipose fin clip and a coded wire tag (CWT). TMs and CWTs are used to estimate the contribution of hatchery stockings to commercial fisheries, marine and freshwater recreational fisheries, and personal use fisheries. They can also be used to estimate spawning escapement in stocked streams, and estimate straying of stocked coho and Chinook salmon.

The accuracy of hatchery contribution estimates is highly dependent upon the accuracy of the estimated number of fish released. To ensure the greatest accuracy in determining the number of fish in release groups, 3 methods are used at FRH and EH: a tagging inventory (TI) count, a hatchery inventory (HI) estimate, and a water volume displacement (WV) estimate. These are compared and the best estimate is used.

Another important element of hatchery smolt stocking programs is fish size. Weight and length of smolt at release are indicators of quality (Peltz and Starkey 1993). If smolt are too small at release, then ocean survival will be poor; and if smolt are too large at release, then ocean residence will be reduced, thus shifting age composition of returns to younger, smaller fish (Sweet and Peltz 1994). To maximize ocean survival of hatchery smolt and achieve an age composition similar to the age composition of an existing population, Peltz and Starkey (1993) recommended that upon release, 80% of hatchery coho salmon smolt weigh between 15.1 and 25.0 g, and that 80% of hatchery Chinook salmon smolt weigh between 5.1 and 15.0 g.

This project documented the release of Chinook and coho salmon smolts with TMs and CWTs in Cook Inlet, Prince William Sound, and Resurrection Bay in 2010. Specific objectives for this project were as follows:

1. Estimate the long-term (greater than 30 days) tag retention rate of each smolt release group with CWTs.
2. Verify the TM applied to the otoliths of fish in each coho and Chinook salmon release group.
3. Estimate the weight distribution of each Chinook salmon smolt release group with CWTs and 1 coho salmon smolt release group without CWTs.

Our tagging goal was to mark all Chinook salmon smolt in 3 release groups with an adipose fin clip and a CWT. A second goal was to mark all fish in all release groups with a thermal mark. We also compared smolt abundance by applying hatchery inventory (HI) and water volume displacement (WV) estimates to the tagging inventory (TI) count for all Chinook salmon release groups marked with an adipose fin clip and a CWT.

Included in this report are recommendations for future marking and collecting of smolt release data. All data for this report are held and archived by Research and Technical Services, Division of Sport Fish, Alaska Department of Fish and Game.

METHODS

Coho salmon smolt from Bear Lake, Ship Creek (Little Susitna River), and Jim Creek donor stocks were raised at Fort Richardson Hatchery (FRH); coho salmon smolt from Ship Creek (Little Susitna River) donor stock were also raised at Elmendorf Hatchery (EH). Chinook salmon smolt from Deception Creek, Crooked Creek, Ship Creek, and Ninilchik River donor stocks were raised at FRH; Chinook salmon smolt from Ship Creek donor stock were also raised at EH. Fish from 20 release groups were stocked at 10 locations in Cook Inlet, 3 locations in Prince William Sound, and 2 locations in Resurrection Bay (Table 1).

Table 1.—Total number of fish stocked at 15 locations in Cook Inlet, Prince William Sound, and Resurrection Bay in 2010.

Species	Release area ^a	Release location	Donor stock	Inventory method	Estimated number in release group
Chinook salmon					
	CI	Deception Creek	Deception Creek	tagging	155,125
	CI	Ship Creek	Ship Creek	hatchery	332,597
	CI	Eklutna Tailrace	Ship Creek	hatchery	152,014 ^b
	CI	Crooked Creek	Crooked Creek	tagging	106,145 ^b
	CI	Halibut Cove	Ninilchik River	hatchery	111,134 ^b
	CI	Homer Spit	Crooked Creek/Ninilchik River	hatchery	213,503 ^b
	CI	Seldovia, Fish Creek	Ninilchik River	hatchery	114,421 ^b
	CI	Ninilchik River	Ninilchik River	tagging	58,297
PWS		Cordova, Fleming Spit	Deception/Ship Creeks	hatchery	111,383 ^b
PWS		Valdez, Old Town Site	Deception Creek	hatchery	113,801 ^b
PWS		Whittier	Deception Creek	hatchery	108,881

-continued-

Table 1.–Part 2 of 2.

Species	Release area ^a	Release location	Donor stock	Inventory method	Estimated number in release group ^b
Chinook (continued)					
	RB	Seward Lagoon	Crooked/Ship Creeks	hatchery	110,671
	RB	Lowell Creek	Crooked Creek	hatchery	109,779
Coho salmon					
	CI	Bird Creek	Ship Cr (Little Susitna River)	hatchery	157,534
	CI	Campbell Creek	Ship Cr (Little Susitna River)	hatchery	50,214
	CI	Eklutna Tailrace	Jim Creek	hatchery	131,123
	CI	Homer Spit	Ship Cr (Little Susitna River)	hatchery	130,206
	CI	Ship Creek	Ship Cr (Little Susitna River)	hatchery	252,319
	RB	Lowell Creek	Bear Lake	hatchery	133,947
	RB	Seward Lagoon	Bear Lake	hatchery	134,008
Total					1,864,701

^a CI is Cook Inlet; PWS is Prince William Sound; RB is Resurrection Bay.

^b Estimated release number adjusted for mortalities that occurred at release sites during imprinting.

SMOLT MARKING

Coded Wire Tagging

All Chinook salmon smolt in 3 release groups were adipose-finclipped and injected with a coded wire tag (CWT; Table 2). Unique tag codes were used for each release group marked with CWTs.

A head mold is used to hold fish in the correct position and orientation for tagging. To determine which head mold sizes would provide the best tag placement, approximately 100 fish from each of the 3 release groups were measured from tip of snout to tail fork (to the nearest millimeter) within 7 days of tagging. Two or 3 head mold sizes that fit at least 80% of the length distribution were selected for tagging (Peltz and Hansen 1994). All fish were graded and tagged accordingly with a full-length CWT (1.1 mm) using a Northwest Marine Technology¹ Mark IV tag injector.

Fish were anesthetized with Tricaine Methane Sulfonate (MS-222) before tagging. The adipose fin was excised at the base using surgical scissors. Tags were then injected into the noses of the fish, and the fish were sent through a Quality Control Device (QCD). The QCD detected the magnetized tag and separated the fish with tags from those without tags. All fish without tags were injected again. Quality control checks for tag placement were conducted following initial daily startup, and following a change in head mold size or a change in tagging personnel. During each quality control check, a minimum of 2 tagged fish were dissected to determine tag placement (Moberly et al. 1977; Figure 1). Head mold or wire placement adjustments were made when necessary. The fish that were dissected to determine tag placement were not included in the tagged fish counts.

¹ Product names used in this publication are included for completeness but do not constitute product endorsement.

Table 2.—Summary of coded-wire-tagging data and smolt release estimates for Chinook salmon stocked in Cook Inlet, 2010.

		Chinook salmon release site			
Release parameter		Deception Creek	Ninilchik River	Crooked Creek	Totals
Fish with adipose finclip and CWT					
Initial number		160,417	58,772	107,326	326,515
Mortalities		5,292	475	1,181	6,948
Total released (tagging inventory)		155,125	58,297	106,145	319,567
Coded Wire Tags					
Tag codes		31-03-80 31-03-81	31-03-79	31-03-78	
Tagging dates		10/28/2010 11/17/2010	10/1/2010 10/14/2010	10/15/2010 10/28/2010	
Date of tag retention check		5/25/2010	5/13/2010	5/25/2010	
Days elapsed since tagging		189	211	209	
Tag retention sample size		891	758	759	
Estimated tag retention at release		99.8%	98.2%	99.1%	
Tag retention variance		2.5E-06	2.39479E-05	1.2055E-05	
Estimated number released with tags		154,815	57,248	105,190	317,252
Tagged fish variance		60,313	78,484	133,386	

After tagging, all fish were held overnight in net pens to determine short-term mortality and short-term tag retention rates. All overnight mortalities were counted and recorded. Short-term retention rates were estimated daily by passing a random sample of 200 fish through the QCD. Daily tag retention rate (D_i) of surviving smolt was estimated as a binomial proportion:

$$\hat{D}_i = \frac{n_i}{n_{ti}} \quad (1)$$

where

n_i = number of live smolt in the sample tagged on day i that retained the tag, and

n_{ti} = total number of live smolt in the sample tagged on day i ,

and tag retention variance was estimated as follows:

$$Var(\hat{D}_i) = \frac{\hat{D}_i(1 - \hat{D}_i)}{n_{ti} - 1}. \quad (2)$$

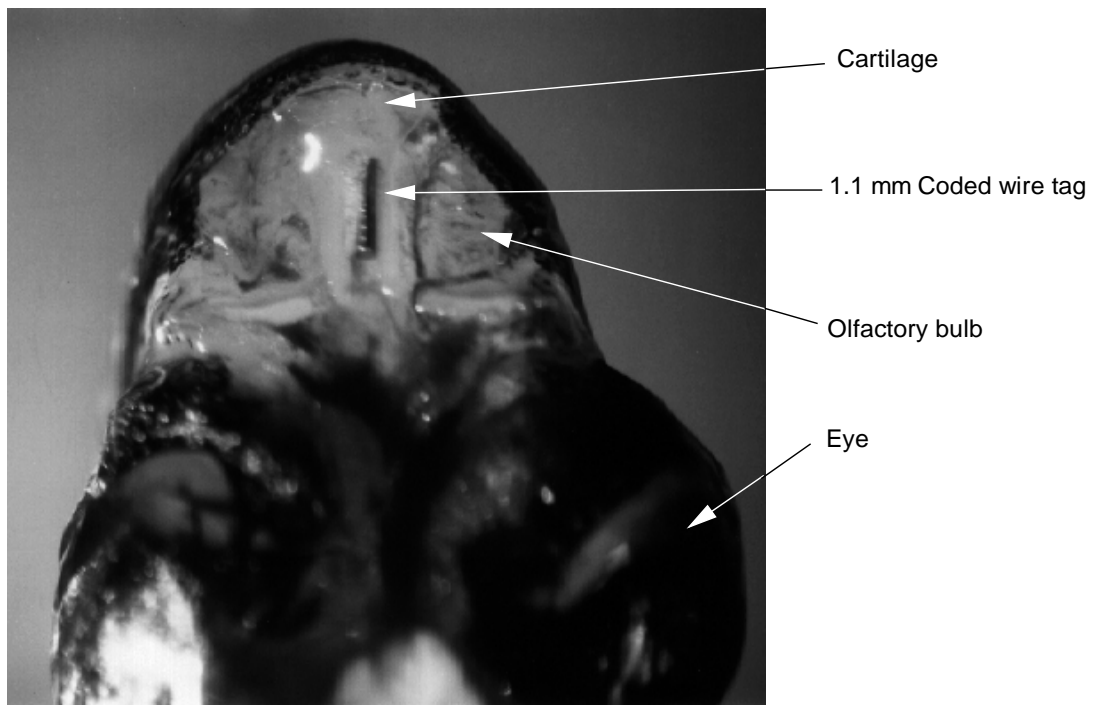
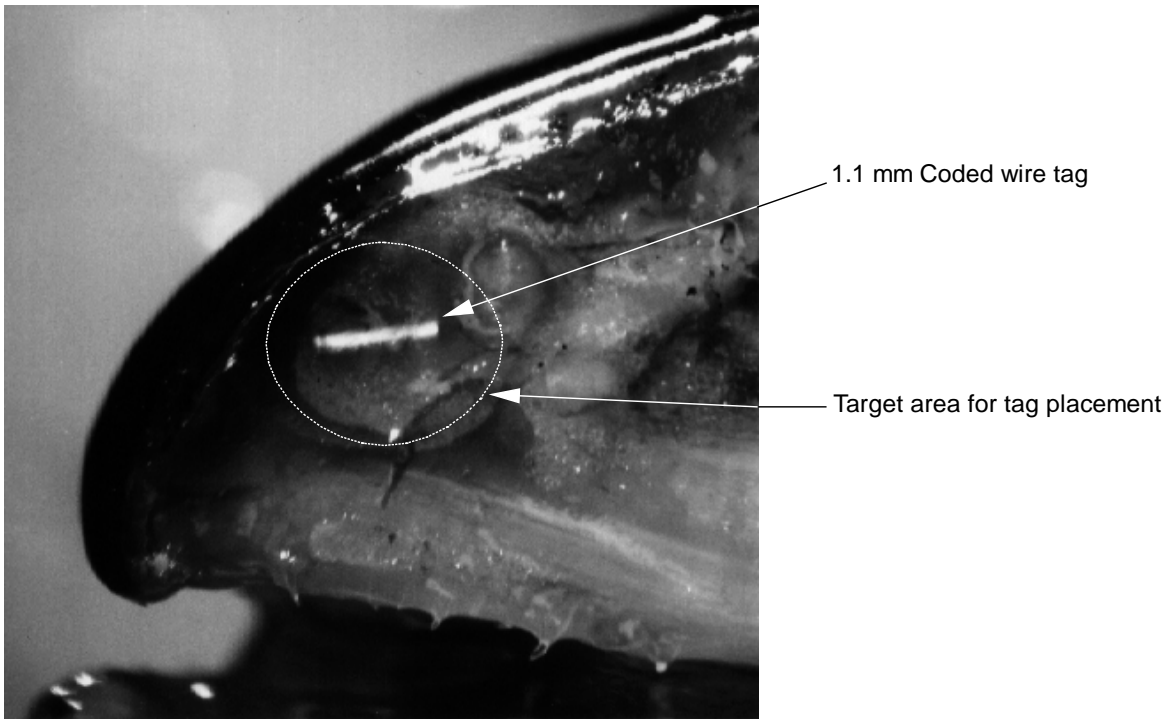


Figure 1.—Proper placement of a coded wire tag in a small fish.

Fish checked for overnight tag retention were also examined for adipose-finclip quality. At least 80% fin removal, as visually estimated by the technician performing the quality control check, was required for the clip to be acceptable.

Tagged smolt were transferred to the rearing unit following overnight mortality checks and held until release. Fish mortality was monitored daily and all mortalities were recorded.

Long-term tag retention was estimated for all release groups at least 30 days after tagging (Blankenship 1990). At least 750 adipose-finclipped fish were randomly sampled from the population and checked for tag retention using a hand-held CWT detector. The long-term tag retention rate (D_j) of surviving smolt and its variance were also estimated as binomial proportions (Equations 1 and 2) for each release group where

n_i = number of smolt in the sample that retained the tag, and

n_{ti} = total number of tagged smolt in the sample.

The number of fish released with CWTs (\hat{T}_j) was estimated as follows:

$$\hat{T}_j = (N_j - M_j) \hat{D}_j \quad (3)$$

and its variance

$$Var(\hat{T}_j) = (N_j - M_j)^2 Var(\hat{D}_j) \quad (4)$$

where

N_j = number of fish injected with a tag in group j ,

\hat{D}_j = long-term tag retention of release group j , and

M_j = total number of mortalities of tagged fish in group j .

Thermal Marks (TMs)

Thermal marks were applied to all coho and Chinook salmon embryos before hatching. Thermal mark patterns were assigned by the Mark, Tag, and Age Laboratory operated by ADF&G Division of Commercial Fisheries (Table 3). At approximately 310 cumulative temperature units (CTUs)—number of days postfertilization multiplied by average daily temperature in centigrade—for coho salmon and 360 CTUs for Chinook salmon, otoliths were developed enough to accept a mark, as verified by the Mark, Tag, and Age Laboratory. Embryos were exposed to a series of 4–5°C water temperature changes (both increases and decreases), with each temperature decrease resulting in the deposit of a dark protein ring on the developing otolith (Monk *Unpublished*). Water temperature changes were scheduled every 24 hours, with a 72-hour warm water exposure occurring between bands of rings. The assigned patterns of dark protein rings applied to the otoliths (Figure 2) are used to identify the area of release from returning adult salmon. Onset Stowaway XTI data loggers recorded incubation water temperature every 15 minutes throughout the marking period to generate thermal profiles for each mark type (Figure 3).

Voucher samples containing approximately 50 fish from each egg lot were collected before moving fish to the raceways (ponding) and submitted to the Mark, Tag, and Age Laboratory for mark verification.

Table 3.—Summary of Chinook and coho salmon thermal marks (hatch codes) for smolt stocked at locations in Cook Inlet, Prince William Sound, and Resurrection Bay in 2010.

Species	Release area ^a	Intended hatch code	Comments ^b	Release locations
Chinook salmon	CI	2,3H	Good mark. Some noise noticed before and after thermal mark.	Ship Creek
				Eklutna Tailrace
				Ninilchik River
				Halibut Cove
				Seldovia
				Homer Spit
Chinook salmon	PWS	2,4H	Nice mark. All lots look similar.	Deception Creek
				Crooked Creek
				Whittier
				Fleming Spit
				Valdez
				Seward Lagoon
Coho salmon	RB	2,5H	All lots look similar, with no variants.	Lowell Creek
Coho salmon	CI	1,5H	Mark is quite noisy. Extra rings noticed in all samples. Variants present.	Ship Creek
				Campbell Creek
				Bird Creek
				Homer Spit
				Eklutna Tailrace
Coho salmon	RB	2,4H	No comment posted	Lowell Creek
				Seward Lagoon

Source: Comments posted by Commercial Fisheries Division Mark, Tag, and Age Laboratory in Voucher Summary Report. Query for report is located at <http://mtalab.adfg.alaska.gov/oto/reports/vouchersummary.aspx>

^a CI is Cook Inlet; PWS is Prince William Sound; RB is Resurrection Bay.

^b Hatch codes indicate the number of rings within each of 2 bands of thermal marks.

Coho Salmon

Coho salmon were thermally marked in 2008 at the eyed egg stage of development (Table 3). Different TMs consisting of 2 bands were applied to identify fish as belonging to Cook Inlet or Resurrection Bay release groups. Cook Inlet release groups were indicated by 1 band of 1 ring followed by 1 band of 5 rings (1,5H), and Resurrection Bay release groups were indicated by 1 band of 2 rings followed by 1 band of 4 rings (2,4H).

Chinook Salmon

Chinook salmon were thermally marked in 2008 at the eyed egg stage of development (Table 3). Different TMs consisting of 2 bands were applied to identify fish as belonging to Cook Inlet, Prince William Sound, or Resurrection Bay release groups. The first band consisted of 2 rings for all fish, and the second band consisted of 3 rings for Cook Inlet release groups (2,3H), 4 rings for Prince William Sound release groups (2,4H), and 5 rings for Resurrection Bay release groups (2,5H).

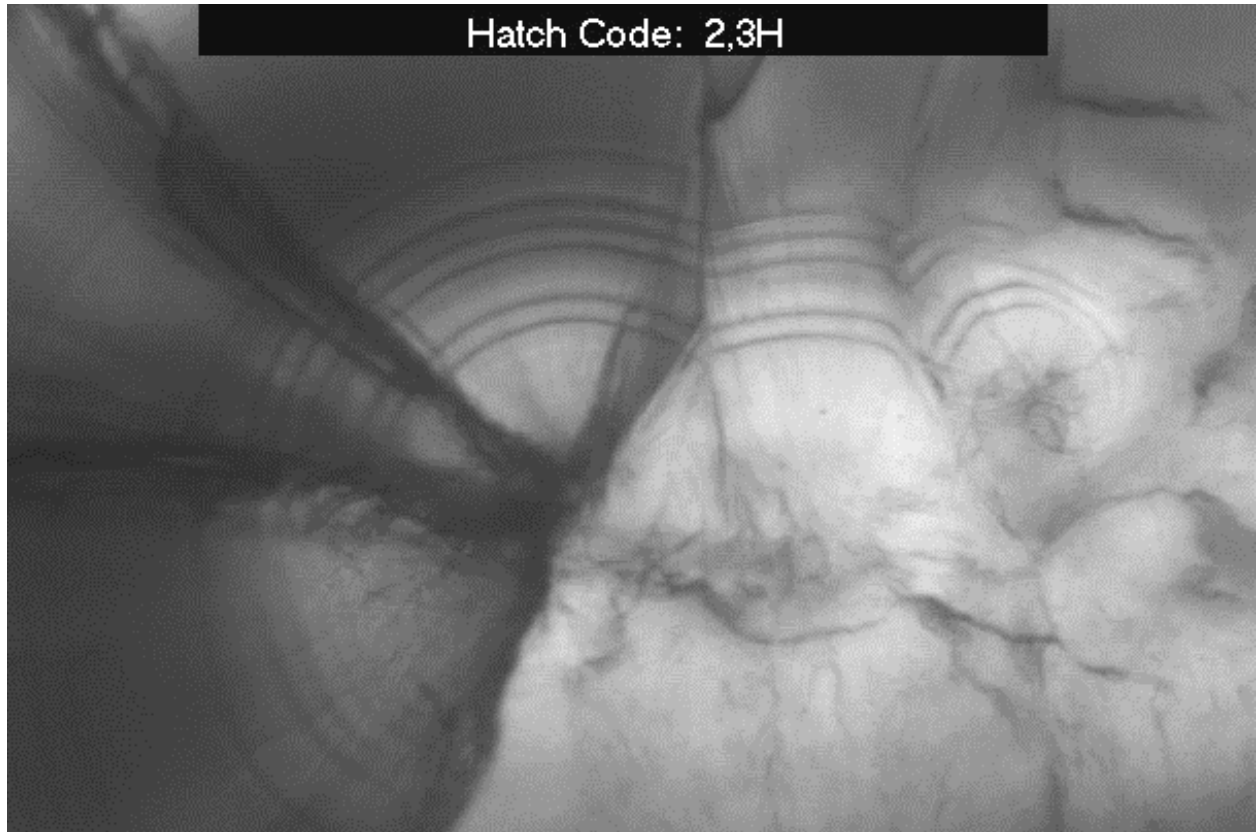


Figure 2.—Image of a thermal mark applied to Chinook salmon released into Cook Inlet.

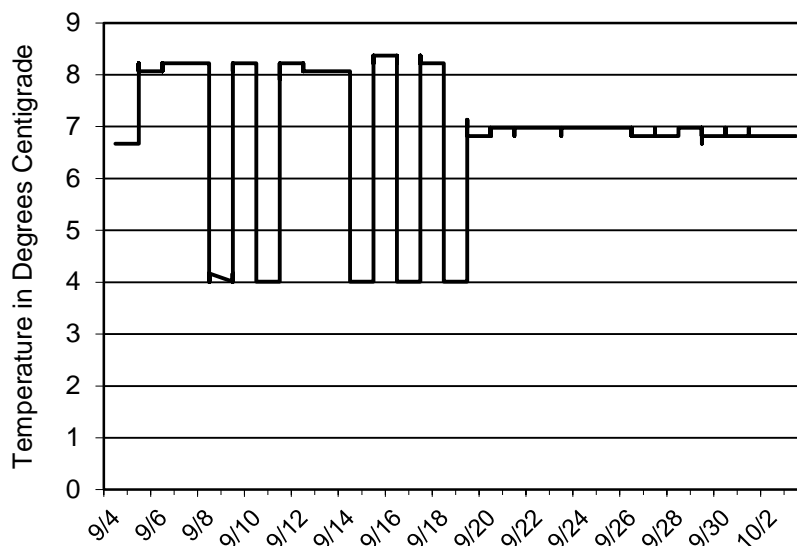


Figure 3.—Thermal marking temperature profile for Chinook salmon released into Cook Inlet in 2010 with a thermal mark (hatch code) of 2,3H.

SMOLT ENUMERATION

The number of fish in all 20 release groups was obtained (before release) using the tagging inventory (TI) count, hatchery inventory (HI) abundance estimate, water volume displacement (WV) abundance estimate, or a combination thereof (see below for details on each of these methods). The TI counts were compared to the HI and WV estimates to determine the precision of the HI and WV estimates. In raceways where a TI was not conducted, and the HI and WV point estimates differed by less than 10%, the HI estimates were used. If the point estimates differed by more than 10%, the estimate from the technique determined to be more accurate when compared to the TI was used.

Tagging Inventory (TI)

A TI count was obtained from the tag counter on the Mark IV CWT injector for the 3 Chinook salmon release groups in which every fish was injected with a CWT. Thus, the number of injected tags counted for each release group equaled the number of fish in each release group. For these release groups, fish mortality was monitored daily and subtracted from the original TI count to yield a final fish count for each release group.

Hatchery Inventory (HI) Estimates

The HI abundance technique used at Fort Richardson Hatchery (FRH) was based on the weight of fish in a raceway. These estimates were obtained when fingerlings were moved from small indoor raceways to large outdoor raceways. Three randomly selected net loads of fish—one each from the head, middle, and tail sections of the raceway—were used to estimate mean fish weight. If the fish were congregated at one end of the raceway, the samples were obtained from the congregation of fish. If a sample varied by more than 5% from the other samples, another sample was obtained. Because a net load of fish is too large to enumerate (approximately 600–800 fish), the net was manually halved numerous times until a visually estimated 50–100 fish remained in the net. Each net of fish was then held out of the water for several seconds to allow water to

drain from the net. The fish were then poured into a preweighed bucket of water, weighed to the nearest gram, and hand counted from the bucket to determine mean fish weight. Mean weight was estimated for each sample by dividing the total weight of the fish counted by the number of fish counted. The total weight of fish, obtained using the accumulative weight feature on the electronic scale, was then divided by the mean fish weight to establish the HI abundance estimate in that raceway. The number of fish released from an outdoor raceway equaled the original outdoor raceway estimate minus the fish stocked or transferred minus the mortalities from date of loading into the outdoor raceway to the date of release.

The HI abundance technique estimates at Elmendorf Hatchery (EH) were based on the weight of fish transferred from FRH to EH. The same HI abundance technique used at FRH for transferring fingerling from indoor to outdoor raceways was employed. The number of fish released from EH equaled the number of fish transferred from FRH to EH minus mortalities from the date of the transfer to the date of release.

Volumetric Estimates (WV)

Fish abundance (number or weight) was also estimated volumetrically using the known size of the transport tank used to transport fish to the release site. This estimate is a function of the tank volume (gallons), the ratio of the volume of water displaced in the tank sight gauge to the volume of water placed in the tank (mm/gallon), and the ratio of the number (or weight) of fish which displace a volume of water in the tank sight gauge (fish/mm or kg/mm).

For fish transport, each tank was filled with water and the water level on the tank sight gauge recorded to the nearest millimeter. Fish were then pumped from the raceway into each of the transport tanks. The water level on the tank gauge was recorded again after fish were loaded into each of the tanks. The millimeters of water displaced for each tank was determined, and using a known displacement value of kilograms of fish per millimeter (Appendix B1), the total weight of fish in the tank was estimated. Total number of fish was estimated by dividing the total fish weight by the mean fish weight.

FRH estimated mean weight by obtaining fish samples from 5 nets of fish before loading the tanks. Each net of fish was split in half several times until the desired sample size (50–100 fish) was achieved. The fish were poured into a preweighed bucket of water, weighed to the nearest gram, and counted out of the bucket. Mean weight was calculated for each of the 5 samples, and an overall mean weight was calculated by summing the 5 sample mean weights and dividing by the sum of the 5 fish counts.

EH estimated mean weight by removing 3 dip net samples of (50–100) fish from the transport tanks on the transport vehicle. Each net of fish was held out of the water for several seconds to allow most of the water to drain out of the net. The fish from each sample were poured into a preweighed bucket of water, weighed to the nearest gram, and counted out of the bucket. Mean weights were calculated for each sample by dividing the sample weight by the number of fish in the sample, and an overall mean weight was calculated by summing the 3 sample mean weights and dividing by the sum of the 3 fish counts. The WV estimate is the number of smolt, as determined by displacement, loaded into the transport tanks at the hatchery.

The smolt mortality that occurs during smolt transfer, release, and imprinting is subtracted from the TI, HI, and WV estimates to obtain the final number of smolt released.

SIZE ESTIMATION

A sample of fish from each raceway containing CWT-tagged Chinook salmon and 1 raceway of coho salmon were individually weighed and measured within 7 days of release. Fish were crowded to one end of a raceway and a minimum of 510 fish were dipnetted and put into a small holding pen. Each fish sampled was measured to the nearest millimeter and weighed to the nearest 0.1 g.

RESULTS

SMOLT MARKING

Coded Wire Tags (CWTs)

Based on tagging inventory counts, 319,567 Chinook salmon smolt with an adipose fin clip and CWT were released in Cook Inlet in 2010 (Table 2). The goal of 100% of the Chinook salmon CWT-tagged in 3 release groups was achieved.

Long-term tag retention was determined 189–211 days after tagging (Table 2). Tag retention rates ranged from 98.2% to 99.8% (Table 2).

Thermal Marks (TMs)

TM digital images of voucher samples revealed that the target hatch code for each Chinook salmon TM was achieved. However, the Cook Inlet Chinook salmon TM has noise present before and after the mark. The Cook Inlet coho salmon TM has extra rings visible in all samples, and variants are present (Table 3). The Resurrection Bay coho salmon target thermal mark hatch code was achieved.

SMOLT RELEASES

In 2010, ADF&G Division of Sport Fish hatcheries released an estimated 989,351 coho salmon smolt at 7 locations in Cook Inlet and Resurrection Bay and an estimated 1,797,751 Chinook salmon smolt at 13 locations in Cook Inlet, Prince William Sound, and Resurrection Bay (Table 1).

SMOLT ENUMERATION

Tagging inventory (TI) counts were reported and compared to the results of hatchery inventory (HI) and water volume displacement (WV) estimation techniques for the 3 TI Chinook salmon release groups. The difference between the point estimates for the HI technique and the TI count ranged from 1.0% to 10.4% with an average point estimate difference of 5.0%. The difference between the point estimates for the WV technique and the TI count ranged from 3.8% to 9.2%, with an average point estimate difference of 5.8% (Table 4). The difference between the HI and WV estimates was greater than 10% for 4 of the 20 rearing units in which both estimates were determined. Because the accuracy of the HI and WV estimates are similar when compared to the TI counts, HI estimates were reported for all 7 coho salmon release groups (989,351, including mortality at the release site) and the 10 release groups of Chinook salmon without CWTs (1,478,184, including mortality at the release site) (Table 4).

Table 4.—A comparison of hatchery inventory (HI) estimates, water volume displacement (WV) population estimates, and tagging inventory (TI) counts (where available) for Chinook and coho salmon reared at Fort Richardson and Elmendorf hatcheries and released in 2010.

Release species and site	Rearing unit	Smolt abundance estimate			Difference			Mortality ^b		Reported release number
		HI ^a	WV ^a	TI ^a	TI/HI	TI/WV	HI/WV	Number	Percent	
Chinook salmon with CWTs										
Crooked Creek	C2	118,745	110,667	106,407	10.4%	3.8%	-7.3%	262	0.25	106,145
Deception Creek	C3	153,576	170,897	155,125	-1.0%	9.2%	10.1%			155,125
Ninilchik River	D2b	60,430	61,064	58,297	3.5%	4.5%	1.0%			58,297
Chinook salmon without CWTs										
Ship Creek	B23/24	332,597	306,987				-8.3%			332,597
Eklutna Tailrace	B4	152,514	126,442				-20.6%	500	0.33	152,014
Halibut Cove	D3	116,719	124,833				6.5%	5,585	4.78	111,134
Homer Spit	C4	119,664	135,376				11.6%	13,867	11.59	105,797
Homer Spit	D2a	112,121	116,308				3.6%	4,415	3.94	107,706
Seldovia	D4	114,921	111,168				-3.4%	500	0.44	114,421
Fleming Spit	B3	111,683	97,867				-14.1%	300	0.27	111,383
Whittier	D1	108,881	101,684				-7.1%	ND	ND	108,881
Valdez	C1	113,906	110,963				-2.7%	105	0.09	113,801
Seward Lagoon	B1	110,671	107,714				-2.7%			110,671
Lowell Creek	B2	109,779	108,706				-1.0%			109,779
Coho salmon without CWTs										
Bird Creek	F3	157,534	163,999				3.9%			157,534
Campbell Cr	E3	50,214	N/A				N/A			50,214
Eklutna Tailrace	F2	131,123	110,567				-18.6%			131,123
Homer Spit	F1	130,791	124,871				-4.7%	585	0.45	130,206
Ship Creek	B23/24	252,319	269,954				6.5%			252,319
Seward Lagoon	E1	134,008	141,947				5.6%			134,008
Lowell Creek	E2	133,947	127,821				-4.8%			133,947

Note: For rearing units that did not contain tagged fish, neither a tagging inventory nor comparisons to a tagging inventory could be obtained.

^a Abundance estimates were established at the hatcheries before any transfer or post-transfer mortality occurred.

^b Mortality includes fish that died during transfer, release, or imprinting at the release site.

Nine release groups were held for imprinting, but mortalities were only reported for 7 Chinook salmon release groups and 1 coho salmon release group (Table 4). An estimated 11.6% (trip 1) and 3.9% (trip 2) of Chinook salmon smolt held in a net pen at Homer Spit died, as well as an estimated 4.8% of Chinook salmon smolt held in a net pen at Halibut Cove Lagoon. Reported smolt mortality at other release sites ranged from 0.09% to 0.45%.

SIZE ESTIMATION

The production goal for coho salmon was to have 80% of the fish weigh between 15.1 and 25.0 g. The 1 coho salmon release group (Bird Creek) sampled for weight did not achieve the production goal (50.8%, Table 5). The production goal for Chinook salmon was to have 80% of the fish weigh between 5.1 and 15.0 g. All 3 Chinook salmon release groups achieved the production goal (Ninilchik River = 98.6%, Deception Creek = 94.0%, Crooked Creek = 94.8%) (Table 5).

Table 5.—The percentage of fish within, below, or above production goal target size for CWT-tagged Chinook salmon release groups and 1 coho salmon release group from Fort Richardson Hatchery in 2010.

Species	Release group	Percent		
		Below target	Within target	Above target
Coho salmon ^a	Bird Creek	48.2%	50.8%	1.0%
Chinook salmon ^b				
	Deception Creek	5.4%	94.0%	0.6%
	Ninilchik River	0.4%	98.6%	1.0%
	Crooked Creek	0.4%	94.8%	4.9%

^a Production goal target for coho salmon: 80% of smolt between 15.1 and 25.0 g

^b Production goal target for Chinook salmon: 80% of smolt between 5.1 and 15.0 g

DISCUSSION

SMOLT MARKING

A point of emphasis for the coded wire tag (CWT) marking program has been to achieve good long-term tag retention rates. Average long-term tag retention for Chinook salmon smolt in 2010 was 99.3%. Acceptable long-term tag retention (greater than 97%) has been achieved by grading fish and using different sizes of head molds.

Thermal Marking

Voucher samples indicate that the TMs for Chinook salmon smolt released into Cook Inlet sites are good and that TM identification is possible even though noise is present before and after the TM. Voucher samples indicate that the TMs for coho salmon released into Cook Inlet sites has extra rings in all samples examined, and variants are present. The target hatch code (1,5H) was achieved, but the extra rings could make TM identification difficult.

SMOLT ENUMERATION

Peltz and Hansen (1994) reported that numerous sources of effort associated with water displacement values make the water volume (WV) displacement method of estimating populations unreliable. They recommended this method be used only when other estimation methods cannot be used or when accuracy is not important.

For each of the 3 CWT-tagged Chinook salmon rearing units, the hatchery inventory (HI) estimates were within 10.4% of the tagging inventory (TI) counts, and the TI counts and WV estimates were within 9.2% of each other. However, the average of the point differences between the TI counts and HI estimates (5.0%) was lower than the average of the point differences between the TI counts and the WV estimates (5.9%),

The TI is the official release number for the 3 CWT-tagged Chinook salmon release groups. Even though the HI estimate for the Crooked Creek release group had the greatest difference from the TI estimate (10.4%) of all the estimates examined, the average of the differences between the TI estimates and the HI estimates (5.0%) was lower than the average of the differences between the TI estimates and the WV estimates (5.9%). For release groups without TI estimates, the difference in WV and HI estimates was greater than 10% for 3 Chinook salmon release groups and 1 coho salmon release group. Because the accuracy of the HI and WV estimates were similar when compared to TI estimates, the HI estimate was reported for these 4 release groups as well as for those release groups with WV and HI estimates within 10% of each other.

ADF&G's Fish Pathology Laboratory confirmed that a marine diatom (*Chaetoceros* sp.) bloom contributed to the death of 18,282 Chinook salmon smolt (7.9% of the combined releases) held for imprinting in net pens anchored in the Nick Dudiak Fishing Lagoon at Homer Spit. An unknown number of Chinook salmon smolt in the Homer Spit release may have died post-release from injuries sustained by the diatom, and marine survival rate for this group may be affected by this diatom bloom. Although unconfirmed, Chinook salmon smolt held in net pens at Halibut Cove Lagoon (approximately 12 miles southeast of Homer Spit) may have been affected by the marine diatom as well because an estimated 5,585 smolt (4.8% of release) died during the 5 days they were held in a net pen for imprinting. Other salt water releases experienced a mortality rate of 0.45% or less during imprinting.

SIZE ESTIMATION

To maximize ocean survival and maintain the age composition of the population, Peltz and Starkey (1993) recommend that 80% of hatchery coho salmon smolt weigh between 15.1 and 25.0 g, and 80% of hatchery Chinook salmon weigh between 5.1 and 15.0 g at time of release. Average water temperature during outdoor rearing (July 2009–June 2010) at FRH for salmon smolt released in 2010 was 0.60°C warmer than it was the previous year for smolt released in 2009 (ADF&G Fort Richardson Hatchery, brood year 2007 and 2008 rearing records for Chinook and coho salmon, unpublished data). Warmer rearing temperatures contributed to a higher percentage (50.8%) of coho salmon achieving the recommended size range in 2010 than in 2009 (4.2%) (Loopstra and Hansen 2015). Ocean survival rates for coho salmon released in 2010 are expected to be better than those of coho salmon released in 2009. The percentages of Chinook salmon that achieved the production goal in 2010 are similar to those achieved in 2009 (Crooked Creek: 2009 = 96.9%, 2010 = 94.6%; Ninilchik River: 2009 = 97.7%, 2010 = 98.6%;

Deception Creek: 2009 = not sampled, 2010 = 94%). Ocean survival rates for Chinook salmon released in 2010 are expected to be similar to those of Chinook salmon released in 2009. Elmendorf Hatchery has the capability of utilizing both well and surface waters for rearing fish. Chinook and coho salmon released into Ship Creek were reared at Elmendorf Hatchery to take advantage of the warmer rearing temperatures of Ship Creek surface water during the summer months. Ship Creek Chinook salmon averaged 13.6 g at release, and Ship Creek coho salmon averaged 23.0 g.

The Valdez Old Town Site release group was transferred to a saltwater net pen and reared an additional 60 days at the release site. Average weight increased from 10.9 g (day of transfer from FRH to net pen) to 24.7 g (day of release). This rearing strategy may increase ocean survival rates, but it will probably result in a return of younger, smaller Chinook salmon (Peltz and Sweet 1993).

RECOMMENDATIONS

- 1) All fish should be graded and tagged using the appropriate head mold sizes.
- 2) Care should be taken in tag placement to increase or maintain acceptable long-term retention rates.
- 3) During thermal marking, temperature changes of 4–5°C should occur every 24 hours between rings, and every 72 hours between bands of rings.
- 4) Production goal size recommendations should be followed such that 80% of coho salmon smolt weigh between 15.1 and 25.0 g, and 80% of Chinook salmon smolt weigh between 5.1 and 15.0 g at release.
- 5) Individual bucket weights should be recorded when determining hatchery inventory estimates in case of electronic scale failure.
- 6) Long-term tag retention rates should be determined after minimum of 30 days.

ACKNOWLEDGMENTS

We would like to thank Andrea Tesch and the staff at Fort Richardson Hatchery for their help and cooperation during thermal marking and coded-wire-tagging operations.

REFERENCES CITED

- Blankenship, H. L. 1990. Effects of time and fish size on coded wire tag loss from Chinook and coho salmon. American Fisheries Society Symposium 7:237-243.
- Loopstra, D. P., and P. A. Hansen. 2015. Coho and Chinook salmon smolt releases into Cook Inlet, Prince William Sound, and Resurrection Bay, Alaska, 2009. Alaska Department of Fish and Game, Fishery Data Series No. 15-29, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/FDS15-29.pdf>
- Moberly, S. A., R. Miller, K. Crandall, and S. Bates. 1977. Marking tag manual for salmon. Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development, Juneau.
- Monk, K. M. *Unpublished*. Thermal marking manual: A guideline to the induction of thermal marks in otoliths for the purpose of mass-marking hatchery stocks. Located at Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Mark, Tag, and Age Laboratory, 10107 Bentwood Place, Juneau, Alaska, 99802-5526.
- Peltz, L., and P. A. Hansen. 1994. Marking, enumeration, and size estimation for coho and Chinook salmon smolt releases into upper Cook Inlet, Alaska in 1993. Alaska Department of Fish and Game, Fishery Data Series No. 94-21, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fds94-21.pdf>
- Peltz, L., and D. Starkey. 1993. Summary and synthesis of production, marking, and release data for coho and Chinook salmon smolt releases into upper Cook Inlet, Alaska in 1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-51, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fds93-51.pdf>
- Peltz, L. R., and D. E. Sweet. 1993. Performance of the Chinook salmon enhancement program in Willow Creek, Alaska, 1985-1992. Alaska Department of Fish and Game, Fishery Data Series No. 93-22, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fds93-22.pdf>
- Sweet, D. E., and L. R. Peltz. 1994. Performance of the Chinook salmon enhancement program in Willow Creek, Alaska, 1985-1993. Alaska Department of Fish and Game, Fishery Manuscript No. 94-3, Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/fms94-03.pdf>

APPENDIX A: HISTORICAL RELEASES OF CHINOOK AND COHO SALMON SMOLTS

Appendix A1.—Historical releases of coho salmon smolt with numbers of thermally marked, adipose-finclipped, and coded-wire-tagged fish.

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Anchorage Urban Streams ^c											
1994	Little Susitna	Ft Richardson	1996	31-25-06	302,857	M-R	93,975	92,565	30.56%		
Bird Creek											
1990	Little Susitna	Ft Richardson	1992	31-20-02, 03	95,377	M-R	44,903	37,629	39.50%		
1991	Little Susitna	Ft Richardson	1993	31-21-39	140,382	M-R	43,441	42,350	30.20%		
1992	Little Susitna	Ft Richardson	1994	31-23-02	84,643	M-R	45,220	44,686	52.80%		
1993	Little Susitna	Ft Richardson	1995	31-23-37	154,753	M-R	45,666	45,490	29.40%		
1994	Little Susitna	Ft Richardson	1996	31-25-04	147,618	M-R	46,528	45,411	30.80%		
1995	Little Susitna	Ft Richardson	1997	31-26-01	146,612	HI	45,901	45,488	31.03%		
1995	Little Susitna	Ft Richardson	1997	31-26-27	147,953	HI	45,836	45,469	30.73%		
1996	Little Susitna	Ft Richardson	1998	31-26-25	164,211	HI	46,140	46,094	28.07%		
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-26-15	111,430	EC	37,344	36,746	32.98%		
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-01-43	97,409	EC	40,114	39,392	40.44%		
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		109,949	HI				CI	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^d		100,605	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		104,974	HI				CI	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		104,979	HI				CI	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		113,035	HI				CI	1,5H
2007	Ship Cr (Little Susitna)	Ft Richardson	2009		113,300	HI				CI	1,5H ^e
2008	Ship Cr (Little Susitna)	Ft Richardson	2010		157,534	HI				CI	1,5H ^f
Campbell Creek ^c											
1990	Little Susitna	Ft Richardson	1992	31-20-04, 05	97,076	M-R	43,681	39,444	40.60%		
1991	Little Susitna	Ft Richardson	1993	31-21-38	140,797	M-R	43,440	42,916	30.50%		
1992	Little Susitna	Ft Richardson	1994	31-23-03	87,686	M-R	44,144	42,963	49.00%		
1993	Little Susitna	Ft Richardson	1995	31-23-36	157,241	M-R	45,655	44,995	28.60%		
1995	Little Susitna	Ft Richardson	1997	31-25-62	71,519	TI	45,840	45,290	63.33%		
1996	Little Susitna	Ft Richardson	1998	31-26-52	83,317	HI	22,453	22,296	26.76%		
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-01-30	42,046	EC	20,879	20,378	48.47%		

-continued-

Appendix A1.–Page 2 of 5.

19

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Campbell Creek ^c (continued)											
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-02-30	63,730	EC	19,948	19,549	30.67%		
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-02-32	69,836	HI	21,568	20,813	29.80%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-01-97	61,323	HI	22,789	21,672	35.34%	CI	5H
2001	Ship Cr (Little Susitna)	Ft Richardson	2003		78,576	HI				CI	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		85,790	HI				CI	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^d		60,387	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		78,405	HI				CI	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		82,794	HI				CI	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		83,421	HI				CI	1.5H
2007	Ship Cr (Little Susitna)	Ft Richardson	2009		15,400	VOL				CI	1,5H ^e
2008	Ship Cr (Little Susitna)	Ft Richardson	2010		50,214	HI				CI	1,5H ^f
Cottonwood Creek											
1990	Fish Creek	Big Lake	1992	31-20-08 31-21-09	53,900	M-R	35,341	32,938	61.10%		
1991	Fish Creek	Big Lake	1993	31-21-41	74,198	M-R	43,117	40,875	55.10%		
Eklutna Tailrace											
1996	Jim Creek	Ft Richardson	1998	31-26-27, 54, 55, 56	112,219	TI	112,219	111,882	99.70%		
1997	Jim Creek	Ft Richardson	1999	31-26-16	126,602	EC	44,073	42,663	33.70%		
1998	Jim Creek	Ft Richardson	2000	31-01-46	76,851	EC	40,514	40,149	52.24%		
1999	Eklutna Tailrace	Ft Richardson	2001	31-02-47	124,838	HI	43,713	43,494	34.84%		
2000	Eklutna Tailrace	Ft Richardson	2002	31-02-46	120,629	HI	44,518	44,295	36.72%	CI	5H
2001	Eklutna Tailrace	Ft Richardson	2003		120,736	HI				CI	5H
2002	Eklutna Tailrace	Ft Richardson	2004		131,979	HI				CI	5H
2003	Eklutna Tailrace	Ft Richardson	2005 ^d		132,149	HI					
2004	Eklutna Tailrace	Ft Richardson	2006		132,212	HI				CI	5H
2005	Eklutna Tailrace	Ft Richardson	2007		118,054	HI				CI	1,5H
2006	Eklutna Tailrace	Ft Richardson	2008		118,139	HI				CI	1,5H

-continued-

Appendix A1.–Page 3 of 5.

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Eklutna Tailrace (continued)											
2007	Jim Creek	Ft Richardson	2009		120,200	HI				CI	1,5H ^e
2008	Jim Creek	Ft Richardson	2010		131,123	HI				CI	1,5H ^f
Fish Creek											
1990	Fish Creek	Big Lake	1992	31-20-12,13	74,953	M-R	45,538	43,625	58.20%		
1991	Fish Creek	Big Lake	1993	31-21-40	67,934	M-R	44,050	43,257	63.70%		
Homer Spit											
1996	Bear Lake	Elmendorf	1998	31-26-28	130,219	M-R	42,057	41,926	32.20%		
1997	Bear Lake	Elmendorf	1999	31-01-40	129,602	M-R	44,405	43,020	33.19%		
	Bear Lake	Elm/Ft. Rich	2000–01 ^d								
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-01-36	100,280	HI	44,992	44,812	44.69%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-01-98	95,648	HI	45,498	44,179	46.19%	CI	5H
2000	Bear Lake	Ft Richardson	2002		120,707	HI				CI	5H
2001	Ship Cr (Little Susitna)	Ft Richardson	2003		222,935	HI				CI	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004		130,243	HI				CI	5H
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^d		125,707	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		125,216	HI				CI	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		127,711	HI				CI	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		122,843	HI				CI	1,5H
2007	Ship Cr (Little Susitna)	Ft Richardson	2009		113,696	HI				CI	1,5H ^e
2008	Ship Cr (Little Susitna)	Ft Richardson	2010		130,206	HI				CI	1,5H ^f
Little Susitna at Houston											
1990	Little Susitna	Ft Richardson	1992	31-20-07	154,466	M-R	21,884	19,564	12.70%		
1991	Little Susitna	Ft Richardson	1993	31-21-37	148,282	M-R	21,404	20,312	13.70%		
Lowell Creek											
2000	Bear Lake	Ft Richardson	2002		119,512	HI				RB	4H
2001	Bear Lake	Ft Richardson	2003		124,389	HI				RB	4H
2002	Bear Lake	Ft Richardson	2004		131,989	HI				RB	4H
2003	Bear Lake	Ft Richardson	2005 ^d		132,276	HI					

-continued-

Appendix A1.–Page 4 of 5.

Brood year	Brood stock	Hatchery	Release year	CWT Code	Total released		Released with coded wire tag			Thermal marking	
					Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Lowell Creek (continued)											
2004	Bear Lake	Ft Richardson	2006		131,261	HI				RB	4H
2005	Bear Lake	Ft Richardson	2007		130,682	HI				RB	2,4H
2007	Bear Lake	Ft Richardson	2009		91,833	HI				RB	2,4H
2008	Bear Lake	Ft Richardson	2010		133,947	HI				RB	2,4H
Nancy Lake											
1990	Little Susitna	Ft Richardson	1992	31-20-06	158,459	M-R	21,598	19,222	12.10%		
1991	Little Susitna	Ft Richardson	1993	31-21-37	131,591	M-R	21,001	19,930	15.20%		
1992	Little Susitna	Ft Richardson	1994	31-23-01	126,694	M-R	44,489	43,818	34.60%		
1993	Little Susitna	Ft Richardson	1995	31-23-39	151,985	M-R	46,261	45,245	29.80%		
Seward Lagoon											
2000	Bear Lake	Ft Richardson	2002		121,743	HI				RB	4H
2001	Bear Lake	Ft Richardson	2003		123,718	HI				RB	4H
2002	Bear Lake	Ft Richardson	2004		131,798	HI				RB	4H
2003	Bear Lake	Ft Richardson	2005 ^d		132,229	HI					
2004	Bear Lake	Ft Richardson	2006		131,326	HI				RB	4H
2005	Bear Lake	Ft Richardson	2007		132,811	HI				RB	2,4H
2006	Bear Lake	Ft Richardson	2008		233,365	HI				RB	2,4H
2007	Bear Lake	Ft Richardson	2009		91,979	HI				RB	2,4H ^e
2008	Bear Lake	Ft Richardson	2010		134,008	HI				RB	2,4H ^f
Ship Creek ^c											
1990	Ship Creek	Elmendorf	1992	31-19-63 31-20-01	67,178	TI	44,086	38,443	57.20%		
1991	Ship Creek	Elmendorf	1993	31-21-36	54,764	PC	42,112	41,322	75.50%		
1992	Ship Creek	Elmendorf	1994	31-23-04	75,779	PC	44,031	41,722	55.10%		
1993	Little Susitna	Ft Richardson	1995	31-23-38	158,981	M-R	45,491	44,654	28.10%		
1995	Little Susitna	Ft Richardson	1997	31-25-63	232,066	TI,HI	45,925	45,741	19.71%		
1996	Little Susitna	Ft Richardson	1998	31-26-53, 26	232,765	HI	67,812	66,997	28.78%		

-continued-

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped	Tagged	Percent tagged	Mark group ^b	Hatch code
Ship Creek ^c (continued)											
1997	Ship Cr (Little Susitna)	Ft Richardson	1999	31-26-14	165,388	EC	48,299	45,380	27.44%		
				31-01-29							
1998	Ship Cr (Little Susitna)	Ft Richardson	2000	31-01-32	260,070	EC	61,640	58,989	22.68%		
				31-01-33							
1999	Ship Cr (Little Susitna)	Ft Richardson	2001	31-02-61	233,563	HI	64,165	61,663	26.40%		
2000	Ship Cr (Little Susitna)	Ft Richardson	2002	31-02-83	212,639	HI	67,959	63,678	29.95%	CI	5H
2001	Ship Cr (Little Susitna)	Ft Richardson	2003	31-02-74, 69	234,716	HI	64,234	64,125	27.32%	CI	5H
2002	Ship Cr (Little Susitna)	Ft Richardson	2004	31-02-81	241,066	HI	63,222	62,906	26.09%	CI	5H
				31-03-15							
2003	Ship Cr (Little Susitna)	Ft Richardson	2005 ^d		251,446	HI					
2004	Ship Cr (Little Susitna)	Ft Richardson	2006		252,775	HI				CI	5H
2005	Ship Cr (Little Susitna)	Ft Richardson	2007		255,400	HI				CI	1,5H
2006	Ship Cr (Little Susitna)	Ft Richardson	2008		245,490	HI				CI	1,5H
2007	Ship Cr (Little Susitna)	Ft Richardson	2009		287,825	HI				CI	1,5H ^e
2008	Ship Cr (Little Susitna)	Elmendorf	2010		252,319	HI				CI	1,5H ^f
Wasilla Creek											
1990	Fish Cr	Big Lake	1992	31-20-10	76,315	M-R	44,148	41,985	55.00%		
				31-20-11							
1991	Fish Cr	Big Lake	1992	31-21-42	77,174	M-R	43,001	41,711	54.10%		
1994	Little Susitna	Ft Richardson	1996	31-25-05	145,923	M-R	46,980	46,839	32.10%		

^a Type of estimate: M-R is mark–recapture; TI is tagging inventory; HI is hatchery inventory; EC is electronic count; PC is physical count.

^b CI is Cook Inlet; RB is Resurrection Bay.

^c Campbell and Ship creeks were combined and termed “Anchorage Urban Streams” in 1996.

^d Stocking continued, but releases did not contain tagged or thermally marked fish.

^e See Loopstra and Hansen (2015).

^f See Table 3 for altered mark details.

Appendix A2.—Historical releases of Chinook salmon smolt with numbers of thermally marked, adipose finclipped, and coded-wire-tagged fish.

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Released	Percent tagged	Mark group ^c	Hatch code
Buskin River											
1994	Deception Cr	Elmendorf	1995	31-24-31	84,349	M-R	41,572	41,078	48.70%		
1995	Deception Cr	Elmendorf	1996	31-25-09	113220	M-R	41259	40681	35.90%		
Crooked Creek											
1993	Crooked Cr	Elmendorf	1994	31-23-14	224,784	M-R	43,609	43,034	19.10%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-27	184,049	M-R	40,903	38,420	20.90%		
1995	Homer (Crooked Cr)	Elmendorf	1996	31-25-12	193,180	M-R	40,827	40,196	20.80%		
1996	Homer (Crooked Cr)	Elmendorf	1997	31-25-55	223,200	M-R	41,049	39,038	17.49%		
1997	Homer (Crooked Cr)	Elmendorf	1998	31-26-29	137,338	M-R	42,874	42,610	31.03%		
1998	Homer (Crooked Cr) ^d	Elmendorf	1999	31-01-41	192,304	M-R	43,431	42,649	22.17%		
1999	Crooked Cr	Elmendorf	2000	31-02-31	108,507	TI	108,507	105,578	97.30%		
				31-01-34, 35							
2000	Crooked Cr	Elmendorf	2001	31-01-95	109,201	TI	109,201	107,454	98.40%		
				31-02-36, 37							
2001	Crooked Cr	Elmendorf	2002	31-02-51	99,547	TI	99,547	98,452	98.90%	CC	2,4H4 ^e
				31-01-96, 99							
2002	Crooked Cr	Ft Richardson	2003	31-02-72, 73, 68	98,800	TI	98,800	94,058	95.20%	CI	2,3H
2002	Crooked Cr	Ft.Richardson	2004	31-02-79, 80	80,601	TI	80,601	75,120	93.20%	CI	2,3H
2003	Crooked Cr	Ft.Richardson	2005	31-03-39, 40, 17	113,613	TI	113,071	113,499	99.90%	CI	2,3H ^f
2004	Crooked Cr ^g	Ft.Richardson	2006	31-03-56, 57, 51	111,705	TI	111,705	111,705	100.0%	CI	2,3H
2005	Crooked Cr ^h	Ft.Richardson	2007	31-03-68, 52	111,382	TI	111,382	111,271	99.9%	CI	2,3H
2006	Crooked Cr	Ft Richardson	2008	31-03-69, 70	114,588	TI	114,588	113,213	98.8%	CI	2,3H
2007	Crooked Cr	Ft Richardson	2009	31-03-75, 74, 14	115,035	TI	114,734	114,115	99.2%	CI	2,3H ⁱ
2008	Crooked Cr	Ft Richardson	2010	31-03-78	106,145	TI	106,145	105,190	99.1%	CI	2,3H
Deception Creek											
1991	Deception Cr	Ft Richardson	1992	31-21-03	179,724	M-R	44,089	33,464	18.60%		
1992	Deception Cr	Ft Richardson	1993	31-21-60	160,194	M-R	42,782	39,420	24.60%		

-continued-

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Deception Creek (continued)											
1993	Deception Cr	Ft Richardson	1994	31-23-17	177,913	M-R	46,289	45,921	25.80%		
1994	Deception Cr	Ft Richardson	1995	31-24-34	184,740	M-R	46,807	46,256	25.00%		
1995	Deception Cr	Ft Richardson	1996	31-25-14	186,918	M-R	47,700	47,145	25.20%		
1996	Deception Cr	Ft Richardson	1997	31-26-03, 04, 05, 06, 07	209,644	TI	209,644	207,973	99.20%		
1997	Deception Cr	Ft Richardson	1998	31-25-32	197,392	TI	197,392	195,615	99.10%		
1998	Deception Cr	Ft Richardson	1999	31-26-17, 18, 19, 20	201,586	TI	201,586	199,722	99.08%		
				31-01-31							
1999	Deception Cr	Ft Richardson	2000	31-26-21	206,496	TI	206,496	205,051	99.30%		
				31-01-44							
				31-02-33, 34, 35							
2000	Deception Cr	Ft Richardson	2001	31-02-41, 42, 43, 44, 45	207,465	TI	207,465	204,560	98.60%		
2001	Deception Cr	Ft Richardson	2002	31-01-92	197,277	TI	197,277	196,608	99.66%	DC	2,5H
				31-02-52, 53, 54, 55							
2002	Deception Cr	Ft Richardson	2003	31-02-70,71	101,181	TI	101,181	99,562	98.40%	CI	2,3H
				31-01-94							
2002	Deception Cr	Ft Richardson	2004	31-02-77, 78	113,523	TI	113,523	104,101	91.70%	CI	2,3H ^j
				31-03-16							
2003	Deception Cr	Elmendorf	2004	31-02-75, 76	99,047	TI	99,047	97,660	98.60%	CI	2,3H
				31-01-27							
2003	Deception Cr	Ft Richardson	2005	31-03-28, 29, 30, 31	163,016	TI	161,991	162,415	99.63%	CI	2,3H ^f
2004	Deception Cr ^g	Ft Richardson	2006	31-03-53, 54, 55, 27	50,426	TI	50,426	50,376	99.90%	CI	2,3H
2005	Deception Cr	Ft Richardson	2007	31-03-67, 26	103,016	TI	103,016	103,016	100.00%	CI	2,3H
2006	Deception Cr	Ft Richardson	2008	31-03-71, 73	112,219	TI	112,219	111,321	99.20%	CI	2,3H
2007	Deception Cr ^g	Ft Richardson	2009	31-03-77, 50, 49	111,322	TI	111,099	111,322	100.00%	CI	2,3H ⁱ
2008	Deception Cr	Ft Richardson	2010	31-03-80, 81	155,125	TI	155,125	154,815	99.80%	CI	2,3H

-continued-

Appendix A2.–Page 3 of 9.

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Eagle River											
1993	Ship Creek	Elmendorf	1994	31-23-13	98,872	M-R	43,612	41,669	42.10%		
Eklutna Tailrace											
2001	Ship Creek	Elmendorf	2002		106,991	VOL				ET	2,3H3
2002	Ship Creek	Ft Richardson	2003		218,492	HI				CI	2,3H
2002	Ship Creek	Ft Richardson	2004		215,165	HI				CI	2,3H ^j
2003	Ship Creek	Ft Richardson	2005		164,586	HI				CI	2,3H ^f
2004	Ship Creek	Ft Richardson	2006		213,250	HI				CI	2,3H
2005	Ship Creek	Ft Richardson	2007		110,978	HI				CI	2,3H
2006	Ship Creek	Ft Richardson	2008		114,136	HI				CI	2,3H
2007	Ship Creek	Ft Richardson	2009		77,785	VOL				CI	2,3H ⁱ
2008	Ship Creek	Ft Richardson	2010		152,014	HI				CI	2,3H
Fleming Spit											
1998	Deception Cr	Ft. Richardson	1999	31-26-23	49,773	TI	45,705	45,385	91.18%		
1999	Deception Cr	Elmendorf	2000	31-01-38	45,000	VIS	17,358	17,236	38.30%		
2000	Deception Cr	Elmendorf	2001	31-02-38	94,812	HI	40,659	40,415	42.63%		
2001	Deception Cr	Ft. Richardson	2002	31-02-57	109,656	HI	40,054	39,573	36.09%	PWS	2,4H
2002	Deception Cr	Ft. Richardson	2003		109,757	HI				PWS	2,4H
2003	Deception Cr	Ft. Richardson	2004		58,000	HI				PWS	2,4H
2003	Deception Cr	Ft. Richardson	2005		87,591	HI				PWS	2,4H ^f
2004	Ship Creek ^k	Ft. Richardson	2006		113,576	HI				CI	2,3H ^k
2005	Deception Cr	Ft. Richardson	2007		119,860	HI				PWS	2,4H
2006	Deception Cr	Ft. Richardson	2008		114,627	HI				PWS	2,4H
2007	Deception Cr	Ft Richardson	2009		68,173	HI				PWS	2,4H
2008	Deception Cr	Ft Richardson	2010		111,383	HI				PWS	2,4H

-continued-

Brood year	Brood stock	Hatchery	Release year	CWT Code	Total released		Released with coded wire tag			Thermal marking	
					Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Halibut Cove											
1993	Crooked Creek	Elmendorf	1994	31-23-15	98,872	M-R	21,205	21,038	21.30%		
1994	Ninilchik River	Elmendorf	1995	31-24-30	37,577	M-R	36,944	36,700	97.70%		
1995	Ninilchik River	Elmendorf	1996	31-25-11	97,729	M-R	40,688	39345	40.30%		
1996	Ninilchik River	Elmendorf	1997	31-25-58	78,133	M-R	40,919	39487	50.54%		
1997	Ninilchik River	Elmendorf	1998	31-26-32	65,893	M-R	38,476	38041	57.73%		
	Ninilchik River	Elmendorf	1999–01 ¹								
2001	Ninilchik River	Elmendorf	2002		106,279	VOL				KB	2,4H3
2002	Ninilchik River	Ft Richardson	2003		106,844	HI				CI	2,3H
2002	Ninilchik River	Ft Richardson	2004		103,771	HI				CI	2,3H
2003	Ninilchik River	Ft Richardson	2005		112,521	HI				CI	2,3H ^f
2004	Ninilchik River	Ft Richardson	2006		117,549	HI				CI	2,3H
2005	Ninilchik River ^h	Ft Richardson	2007		54,560	HI				CI	2,3H
2006	Ninilchik River	Ft Richardson	2008		58,674	HI				CI	2,3H
2007	Ninilchik River	Ft Richardson	2009		35,065	WV				CI	2,3H ⁱ
2008	Ninilchik River	Ft Richardson	2010		111,134	HI				CI	2,3H
Homer Spit (early run)											
1993	Crooked Creek	Elmendorf	1994	31-23-16	163,963	M-R	26,003	25,615	15.60%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-32	216,026	M-R	41,650	40,291	18.70%		
1995	Homer (Crooked Cr)	Elmendorf	1996	31-25-07	204,085	M-R	40,868	39,017	19.10%		
1996	Homer (Crooked Cr)	Elmendorf	1997	31-25-60	217,773	M-R	41,112	38,810	17.82%		
1997	Homer (Crooked Cr)	Elmendorf	1998	31-26-33	177,730	M-R	40,012	39,652	22.31%		
1998	Homer (Crooked Cr)	Elmendorf	1999	31-01-45	163,170	M-R	42,561	40,423	24.77%		
	Ninilchik River	Elmendorf	2000–01 ¹								
2001	Ninilchik River	Elmendorf	2002		190,026	VOL				KB	2,5H3
2002	Ninilchik River	Ft Richardson	2003		206,292	HI				CI	2,3H
2002	Ninilchik River	Ft Richardson	2004		143,037	HI				CI	2,3H
2003	Ninilchik River	Elmendorf	2004		25,706	VOL				CI	2,3H
2003	Ninilchik River	Ft Richardson	2005		220,822	HI				CI	2,3H ^f
2004	Ninilchik River	Ft Richardson	2006		224,053	HI				CI	2,3H

-continued-

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Homer Spit (early run, continued)											
2005	Ninilchik River	Ft Richardson	2007		226,972	HI				CI	2,3H
2006	Ninilchik River	Ft Richardson	2008		212,141	HI				CI	2,3H
2007	Ninilchik River	Ft Richardson	2009		164,234	HI				CI	2,3H ⁱ
2008	Ninilchik River	Ft Richardson	2010		107,706	HI				CI	2,3H
2008	Crooked Creek	Ft Richardson	2010		105,797	HI				CI	2,3H
Homer Spit (late run)											
1992	Kasilof River	Crooked Creek	1994	31-23-19	56,920	M-R	22,612	22,383	39.30%		
1994	Homer (Kasilof R)	Elmendorf	1995	31-24-33	123,048	M-R	41,054	40,466	32.90%		
1995	Homer (Kasilof R)	Elmendorf	1996	31-25-13	108,204	M-R	40,615	38,787	35.80%		
1996	Homer (Kasilof R)	Elmendorf	1997	31-25-61	100,933	M-R	41,028	39,264	38.90%		
1997	Homer (Kasilof R)	Elmendorf	1998	31-26-34	112,100	HI	40,158	39,997	35.68%		
	Homer (Kasilof R)	Elmendorf	1999 ¹								
Lowell Creek											
1996	Deception Cr	Elmendorf	1997	31-25-59	102,147	M-R	40,906	40,497	39.65%		
	Deception Cr	Elmendorf	1998–99 ¹								
	Crooked Creek	Elmendorf	2000–01 ¹								
2001	Crooked Creek	Elmendorf	2002		93,296	VOL				RB	2,5H3
2002	Crooked Creek	Ft Richardson	2003		110,331	HI				RB	2,5H
2002	Crooked Creek	Ft Richardson	2004		89,388	HI				RB	2,5H
2003	Crooked Creek	Ft Richardson	2005		100,088	HI				RB	2,5H ^f
2008	Crooked Creek	Ft Richardson	2010		109,779	HI				RB	2,5H
Ninilchik River											
1991	Ninilchik River	Ft Richardson	1992	31-21-04	132,387	M-R	43,648	41,335	31.20%		
1992	Ninilchik River	Ft Richardson	1993	31-21-59	184,585	M-R	44,487	42,960	23.30%		
1993	Ninilchik River	Ft Richardson	1994	31-23-18	201,513	M-R	46,193	45,535	22.60%		
1994	Ninilchik River	Ft Richardson	1995	31-24-35	54,902	TI	54,902	54,353	99.00%		
1995	Ninilchik River	Ft Richardson	1996	31-25-15	51,688	TI	51,588	50,866	98.60%		

-continued-

Appendix A2.–Page 6 of 9.

Brood year	Brood stock	Hatchery	Release year	CWT Code	Total released		Released with coded wire tag			Thermal marking	
					Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Ninilchik River (continued)											
1996	Ninilchik River	Ft Richardson	1997	31-26-08	50,698	TI	50,698	50,292	99.20%		
1997	Ninilchik River	Ft Richardson	1998	31-26-35	48,798	TI	48,798	47,480	97.30%		
1998	Ninilchik River	Ft Richardson	1999	31-01-47	49,853	TI	49,853	48,906	98.10%		
1999	Ninilchik River	Ft Richardson	2000	31-02-48	51,298	TI	51,298	50,016	97.50%		
2000	Ninilchik River	Ft Richardson	2001	31-02-60	54,770	TI	54,770	54,441	99.40%		
2001	Ninilchik River	Ft Richardson	2002	31-02-82	54,631	TI	54,631	54,139	99.10%	NR	2,3H
2002	Ninilchik River	Ft Richardson	2003	31-02-56	47,997	TI	47,997	44,349	92.40%	CI	2,3H
				31-01-83							
2002	Ninilchik River	Ft Richardson	2004	31-03-18	51,303	TI	51,303	51,252	99.90%	CI	2,3H
2003	Ninilchik River	Ft Richardson	2005	31-03-41	55,229	TI	54,806	54,898	99.40%	CI	2,3H ^f
2004	Ninilchik River ^g	Ft Richardson	2006	31-03-58	57,537	TI	57,537	57,537	100.00%	CI	2,3H
2005	Ninilchik River	Ft Richardson	2007	31-03-66	56,325	TI	56,037	55,869	99.19%	CI	2,3H
2006	Ninilchik River	Ft Richardson	2008	31-03-72	56,943	TI	56,868	56,658	99.50%	CI	2,3H
2007	Ninilchik River	Ft Richardson	2009	31-03-76	54,797	TI	54,797	54,304	99.10%	CI	2,3H ⁱ
2008	Ninilchik River	Ft Richardson	2010	31-03-79	58,297	TI	58,297	57,248	98.20%	CI	2,3H
Seldovia											
1993	Crooked Creek	Elmendorf	1994	31-23-11	107,246	M-R	46,754	45,439	42.40%		
1994	Homer (Crooked Cr)	Elmendorf	1995	31-24-29	116,165	M-R	41,609	40,678	35.00%		
1995	Ninilchik River	Elmendorf	1996	31-25-10	118,274	M-R	40,667	39,610	33.50%		
1996	Ninilchik River	Elmendorf	1997	31-25-57	103,757	M-R	41,279	39,834	38.39%		
1997	Ninilchik River	Elmendorf	1998	31-26-31	69,461	M-R	40,654	40,125	57.77%		
	Ninilchik River	Elmendorf	1999–01 ¹								
2001	Ninilchik River	Elmendorf	2002		83,045	VOL				KB	2,4H3
2002	Ninilchik River	Ft Richardson	2003		107,521	HI				CI	2,3H
2003	Ninilchik River	Elmendorf	2004		88,682	VOL				CI	2,3H
2003	Ninilchik River	Ft Richardson	2005		114,984	HI				CI	2,3H ^f
2004	Ninilchik River	Ft Richardson	2006		113,974	HI				CI	2,3H
2005	Ninilchik River	Ft Richardson	2006		54,276	HI				CI	2,3H
2006	Ninilchik Rver	Ft Richardson	2008		54,464	HI				CI	2,3H
2007	Ninilchik Rver	Ft Richardson	2009		44,487	VOL				CI	2,3H ⁱ
2008	Ninilchik River	Ft Richardson	2010		114,421	HI				CI	2,3H

-continued-

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Seward Lagoon											
2001	Crooked Creek	Elmendorf	2002		100,314	VOL				RB	2,5H3
2002	Crooked Creek	Ft. Richardson	2003		109,976	HI				RB	2,5H
2003	Crooked Creek	Elmendorf	2004		109,600	VOL				RB	2,5H
2003	Crooked Creek	Ft. Richardson	2005		114,847	HI				RB	2,5H ^f
2004	Deception/Crooked Cks	Ft. Richardson	2006		116,826	HI				RB	2,5H
2004	Ship Creek ^k	Ft. Richardson	2006		109,795	HI				CI	2,3H ^k
2008	Crooked/Ship Cks	Ft Richardson	2010		110,671	HI				RB	2,5H
Ship Creek											
1993	Ship Creek	Elmendorf	1994	31-23-12	199,830	M-R	44,138	42,864	21.50%		
1994	Ship Creek	Elmendorf	1995	31-24-28	218,487	M-R	40,764	38,570	17.70%		
1995	Ship Creek	Elmendorf	1996	31-25-08	231,444	M-R	41,221	40,109	17.30%		
1996	Ship Creek	Elmendorf	1997	31-25-56	326,371	M-R	40,522	40,319	12.36%		
1997	Ship Creek	Elmendorf	1998	31-26-30	204,741	M-R	42,073	41,565	20.30%		
1998	Ship Creek	Elmendorf	1999	31-01-42	197,168	M-R	44,265	42,262	21.44%		
	Ship Creek	Elmendorf	2000–01 ¹								
2001	Ship Creek	Elmendorf	2002		290,501	VOL				SC	2,4H4
2002	Ship Creek	Ft Richardson	2003		329,416	HI				CI	2,3H
2002	Ship Creek	Ft Richardson	2004		209,060	HI				CI	2,3H ^j
2003	Ship Creek	Elmendorf	2004		111,166	HI				CI	2,3H
2003	Ship Creek	Ft Richardson	2005		344,191	HI				CI	2,3H ^f
2004	Ship Creek	Elmendorf	2005		13,838	VOL					
2004	Ship Creek	Ft Richardson	2006		60,412	HI				CI	2,3H
2004	Ship Creek ^k	Ft Richardson	2006		115,643	HI				PWS	2,4H ^k
2005	Ship Creek	Ft Richardson	2007		333,940	HI				CI	2,3H
2006	Ship Creek	Ft Richardson	2008		341,495	HI				CI	2,3H
2007	Ship Creek	Ft Richardson	2009		282,735	HI				CI	2,3H ⁱ
2008	Ship Creek	Elmendorf	2010		332,597	HI				CI	2,3H

-continued-

					Total released		Released with coded wire tag			Thermal marking	
Brood year	Brood stock	Hatchery	Release year	CWT Code	Estimate	Type ^a	Clipped ^b	Tagged	Percent tagged	Mark group ^c	Hatch code
Valdez Area											
1998	Deception Cr	Ft Richardson	1999	31-26-22	49,353	TI	46,528	45,923	93.05%		
1999	Deception Cr	Elmendorf	2000	31-01-37	115,582	M-R	41,728	41,060	35.52%		
2000	Deception Cr	Elmendorf	2001	31-02-39	94,701	HI	44,418	43,974	46.43%		
2001	Deception Cr	Ft Richardson	2002	31-02-58	107,861	HI	43,833	42,650	39.54%	PWS	2,4H
2002	Deception Cr	Ft Richardson	2003		109,661	HI				PWS	2,4H
2002	Deception Cr	Ft Richardson	2004		99,464	HI				PWS	2,4H ^j
2003	Deception Cr	Ft Richardson	2005		143,209	HI				PWS	2,4H ^f
2004	Ship Creek	Ft Richardson	2006		112,221	HI				PWS	2,4H
2005	Deception Cr	Ft Richardson	2007		126,241	HI				PWS	2,4H
2006	Deception Cr	Ft Richardson	2008		126,703	HI				PWS	2,4H
2007	Deception Cr	Ft Richardson	2009		107,883	HI				PWS	2,4H
2008	Deception Cr	Ft Richardson	2010		113,801	HI				PWS	2,4H
Whittier Area											
1998	Deception Cr	Ft Richardson	1999	31-26-24	49,797	TI	45,023	43,897	88.21%		
1999	Deception Cr	Elmendorf	2000	31-01-39	119,389	M-R	43,551	42,898	35.93%		
2000	Deception Cr	Elmendorf	2001	31-02-40	95,823	HI	42,800	42,458	44.31%		
2001	Deception Cr	Ft Richardson	2002	31-02-59	109,763	HI	45,854	44,799	40.81%	PWS	2,4H
2002	Deception Cr	Ft Richardson	2003		109,700	HI				PWS	2,4H
2002	Deception Cr	Ft Richardson	2004		107,705	HI				PWS	2,4H ^j
2003	Deception Cr	Elmendorf	2004		20,906	VOL				PWS	2,4H
2003	Deception Cr	Ft Richardson	2005		118,059	HI				PWS	2,4H ^f
2008	Deception /Ship Cks	Ft Richardson	2010		108,881	HI				PWS	2,4H

^a Type of estimate: M-R is mark–recapture; TI is tagging inventory; HI is hatchery inventory; VIS is a visual estimate; VOL is volumetric estimate.

^b Beginning in 2005, number of clipped fish released is adjusted to reflect percent of acceptable finclips observed at release.

^c CC is Crooked Creek; CI is Cook Inlet; DC is Deception Creek; ET is Eklutna Tailrace; KB is Kachemak Bay; NR is Ninilchik River; PWS is Prince William Sound; RB is Resurrection Bay; SC is Ship Creek.

^d Corrections for release numbers reported in Loopstra et al. (2000).

^e See Loopstra and Hansen (2005) for altered mark details.

-continued-

- ^f See Loopstra and Hansen (2008) for altered mark details.
- ^g Not sampled for long-term coded wire tag retention or finclip quality at release. Coded wire tag data are based on overnight tag retention and acceptable finclip rates.
- ^h Corrections for release numbers reported in Loopstra and Hansen (2010).
- ⁱ See Loopstra and Hansen (2015).
- ^j See Loopstra and Hansen (2007) for altered mark details.
- ^k Due to bacterial kidney disease (BKD) infection, release groups were switched at release in order to stock healthier fish at brood source release sites.
- ^l Stocking continued, but releases did not contain tagged or thermally marked fish.

APPENDIX B: DISPLACEMENT VALUES FOR FISH TRANSPORT TANKS

Appendix B1.—Displacement values (kg/mm) for fish transport tanks.

Vehicle	Displacement kg/mm
SV33804	2.70
SV36544	2.60
SV36905	1.42
SV33697	2.20
SV33259	3.21

Source: John Unterberg, ADF&G, Fort Richardson Fish Hatchery, December 2010.